Key Conditions at a Glance

Table 2, below, compares five key indicators of eutrophication — degree of nutrient enrichment, algal biomass, and overall metabolic activity (dissolved oxygen and pH) — in four Eastern Washington rivers. Each river has a different geologic and hydrologic setting, which would be taken into account in a more thorough comparison. However, evaluating these few indicators at least allows a comparison of the severity of concern in each river.

In brief, nitrogen concentrations were highest in the Yakima River. Phosphorus concentrations were similar in the Yakima and Walla Walla rivers. The highest algal biomass occurred in the Spokane River, but only for a single sample. One-third of the Yakima River algae samples exceeded a non-regulatory nuisance level of 100 mg/m^2. The lowest dissolved oxygen concentrations occurred in the Yakima River, except for anoxic conditions in Lake Spokane, which much lower than the Spokane River itself. The worst pH conditions occurred in the Yakima River. The dissolved oxygen and pH data in the table were from continuous monitors, except for the Lake Spokane data.

Table 2: Comparison of five indicators of eutrophication between four Eastern Washington rivers (during different years).

River	Dissolved inorganic nitrogen concentration (mg/L) minimum to maximum	Ortho phosphate concentration (mg/L) (also known as SRP and dissolved inorganic P) minimum to maximum	Attached algal biomass (chlorophyll *a* mg/m2) minimum to maximum	Lowest daily minimum dissolved oxygen concentration (mg/L) where, how many days, when?	Highest daily maximum pH value where, how many days, when?
Yakima	**0.1** to **1.2** Selah Gap to Prosser Dam July 04	**0.022** to **0.14** Selah Gap to Prosser Dam July 04	**12** to **340** RM 29.9 to RM 103.8 June 05, Jul-Oct. 06 and July-Sept. 07	**< 3.1** RM 29.9, 7 out of 347 days, April-Sept. 04-05.	**9.5** to **9.8** RM 29.9, 52 out of 878 days, April-Sept. 04, 05, 06, 07.
Walla Walla	**0.01** to **0.85** RM 27.4 to RM 32.8 May-Oct. 02-03	**0.027** to **0.18** RM 38.7 to RM 22.7 May-Oct. 02-03	**80** and **180** RM 15.6 and RM 38.7 Jul-Aug 02	**6.5** to **4.0** RM 29.3, 5 out of 5 days, June 03.	**9.4** to **9.6** RM 29.3, 5 out of 5 days, June 03.
Wenatchee	**≤ 0.01** to **0.26** RM 25-55 to near mouth June-Oct. 02 and Apr, Sept. 03 (nitrate+nitrite only)	**≤ 0.003** to **0.019** RM 25-55 to RM 6.5 June-Oct. 02 and Apr, Sept. 03	**18** to **120** RM 35.4 to RM 2.8-10.8 4 samples, Sept. 02	**< 6** in side channel **7.9-7.9** lower main channel 3 sites, 3 out of 15 days, July-Oct.02	**9.0** to **9.5** RM 1.0, 4 out of 4 days, Aug-Oct. 02, Apr 03
Spokane	**0.067** to **0.83** Stateline to Riverside State Park June-Oct. 01 average	**0.007** to **0.010** Stateline to Riverside Bridge June-Oct. 01 average	**4-28** to **6-570** RM 85-90 to RM 58-78 8 sites, Aug.-Sept. 01	**7.0** in river; **0** in lake Stateline, 3 out of 13 days, Aug. 01	**8.9** Stateline, 7 out of 13 days, Aug. 01

RM=river mile

What Comes Next?

When Ecology evaluates how to improve water quality in a river, they do so using data specific to that river as much as possible. The clean-up plans or assessments for the Wenatchee, Walla Walla, and Spokane rivers all require sewage treatment plant upgrades and encourage voluntary nutrient-reducing efforts by private landowners (e.g., homeowners, farmers). But that is not necessarily what will happen in the Yakima River. The clean-up strategy for the Yakima River will only be developed after extensive modeling of the factors which cause dissolved oxygen and pH violations.

We have provided the information in this handout to keep you informed of an emerging issue — nutrients in the Yakima River — and how the same issue has been approached in other watersheds. When Ecology asks for public input on their approach to solving the nutrient problem in the Yakima River, we encourage you to participate because we believe it is in your best interest to get involved early in the process instead of late.

This handout is one of a series of five handouts on different topics relating to nutrient-enrichment processes in the lower Yakima River. For more information, contact the South Yakima Conservation District at (509) 837-7911.

Draft

Yakima River: Future Clean-up Plan for Excess Nutrients

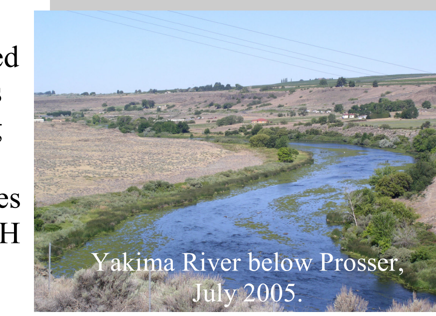
South Yakima Conservation District

April 2008

Benton Conservation District

Excess nutrients in rivers can result in water quality problems such as low dissolved oxygen and high pH levels because nutrients encourage algal and aquatic plant growth. Because the lower Yakima River has known violations of the dissolved oxygen and pH standards, in the future the Department of Ecology must develop a clean-up plan to address the violations by determining the nutrient concentrations needed to reduce algal or plant growth. Everyone wants clean water in our rivers. However, the specific requirements in cleanup plans for other Eastern Washington rivers have created concerns in local communities about how to pay for the needed improvements. We reviewed cleanup plans for the Wenatchee, Walla Walla, and Spokane rivers to see the outcome of Ecology's goal-setting process in three very different watersheds and to compare conditions in the other rivers against conditions in the lower Yakima River.

Lower Yakima River Conditions



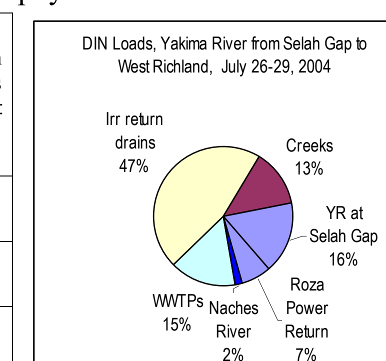
Yakima River below Prosser, July 2005.

In the lower Yakima River,* elevated nutrient concentrations encouraged excessive amounts of algae to grow on the river bottom and cling to rooted aquatic plants when other habitat conditions did not limit growth (such as insufficient light or excess water velocity). The amount of algae growing on the river bottom exceeded a non-regulatory nuisance threshold of 100 milligrams per square meter (mg/m^2) chlorophyll *a* in 18 out of 48 samples taken over three years. In 2004, violations of the dissolved oxygen and pH standards occurred in all reaches of the lower 116 miles of the river. Dissolved oxygen concentrations were lowest in the Kiona reach, which had abundant plant growth. The pH was as high at the most upstream site in Selah Gap as at the lowest site near West Richland. In 2005, the Zillah reach had the most days with dissolved oxygen violations, but the Kiona reach had lower (worse) minimum values (Table 1). The Kiona reach had the most days with pH violations. In 2006-07, when the amount of aquatic plants in the Kiona reach decreased substantially, there were fewer and less extreme dissolved oxygen and pH violations than in 2005.

The Department of Ecology's clean-up plans use the ratio of nitrogen-to-phosphorus concentrations in the river to indicate which nutrient would first limit algal growth. Based on these ratios, the lower Yakima River would be potentially nitrogen-limiting from Selah Gap to upstream of Granger, then phosphorus-limiting the rest of the river. Algal growth rate experiments conducted in 2006 and 2007 with periphytometers — nutrient-dosed artificial substrate placed in the river — showed no response, suggesting that nutrient limitation was not occurring. The largest source (load) of biologically-available nitrogen was irrigation return drains and creeks (60%) while the largest sources of biologically-available phosphorus were wastewater (sewage) treatment plants (30%) and irrigation return drains and creeks (23%).

Reach	# days with DO violation	# days with pH violation	10% of minimum DO values fell below:	10% of maximum pH values fell above:
Zillah	207 out of 222	154 out of 222	6.1 mg/L	9.4
Mabton	57 out of 211	79 out of 233	6.8 mg/L	8.9
Kiona	174 out of 229	208 out of 229	4.2 mg/L	9.5

Table 1. Dissolved oxygen and pH conditions.



**For information on the Yakima River, we relied on data from the Lower Yakima River Eutrophication study conducted by the U.S. Geological Survey, South Yakima Conservation District, and Benton Conservation District. The report has not yet been published; all data are preliminary.*

Clean-up Plans for Other Eastern Washington Rivers

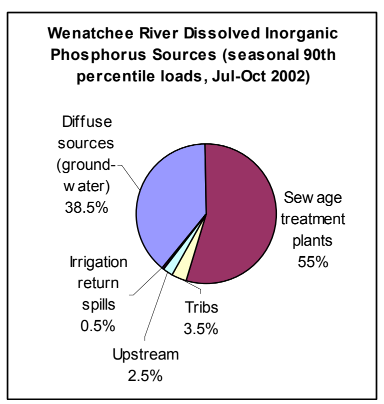
Wenatchee River


Wenatchee River near Dryden. Photo courtesy of NWPortal

The Department of Ecology is currently working with local organizations to develop the clean-up plan for the Wenatchee River. In their technical assessment of the river, the Department of Ecology found that excess algae growing on the river bottom in the lower part of the river (below Leavenworth) caused violations of the dissolved oxygen and pH standards.

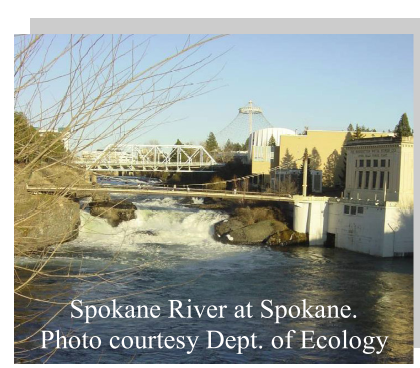
Out of 18 short-term (generally 24-hour) deployments of continuous monitors during July – October 2002 and April 2003 in the lower part of the river, the dissolved oxygen standard of 8.0 milligrams per liter (mg/L) was not met 3 days while the pH standard was not met on 12 days. Ecology concluded, based on nitrogen-to-phosphorus ratios, that phosphorus was limiting algal growth. Reducing instream soluble reactive phosphorus (biologically-available) concentrations from the current range of 0.003 to 0.019 mg/L to consistently near 0.003 mg/L would 'starve' the algae and thus improve dissolved oxygen and pH conditions. Part of the reason for fewer dissolved oxygen violations than pH violations was the large number of riffles, which quickly bring oxygen back into the water.

However, Ecology found numerous dissolved oxygen violations in the upper part (most pristine) of the Wenatchee River, where there is a more stringent state standard. Out of 16 short-term deployment of continuous monitors during July – October 2002 and April 2003 in the upper part of the river, the dissolved oxygen standard of 9.5 mg/L was not met on nine days while the pH standard was always met. Natural dissolved oxygen concentrations would be expected to not meet the state standard of 9.5 mg/L during summer due to high land elevations and high water temperatures, both of which physically reduce water's ability to keep oxygen in solution.



Most of the phosphorus in the lower Wenatchee River comes from groundwater seeping into the river and sewage treatment plants. The assessment did not establish nutrient goals for individual sources because the broad goal of reducing phosphorus by 80% was not considered a viable strategy, since it would restrict nonpoint phosphorus levels to below natural background levels. Ecology intends to conduct additional modeling to address this and other concerns, then establish final clean-up goals. One specific recommendation in the assessment, which may or may not be included in the final clean-up plan, was that the Lake Wenatchee's sewage treatment plant should not discharge to the river during March through October; the treatment plant currently land applies during the summer.

Spokane River


Spokane River at Spokane. Photo courtesy Dept. of Ecology

Concerns have existed for decades about blue-green algae blooms in Lake Spokane, where the Spokane River is impounded behind a hydroelectric dam. Less well-known is the abundance of algae growing on the river bottom, which exceeded non-regulatory nuisance levels in the lower reaches when sampled in 1984 and 2001.

Based on nitrogen-to-phosphorus ratios, Ecology concluded the river was strongly nitrogen-limited above river mile 87 near Sullivan Road but was phosphorus-limited below river mile 85 at Trent Road, including in Lake Spokane. Sources of phosphorus were primarily wastewater treatment plants, which contributed about 56% of the phosphorus in the river, the rest coming from nonpoint pollution and natural background sources of phosphorus. There were seven wastewater plants in the studied area: five municipal sewage treatment plants (3 in Idaho, 2 in Washington) and two industrial wastewater treatment plants.

(Continued on next page)

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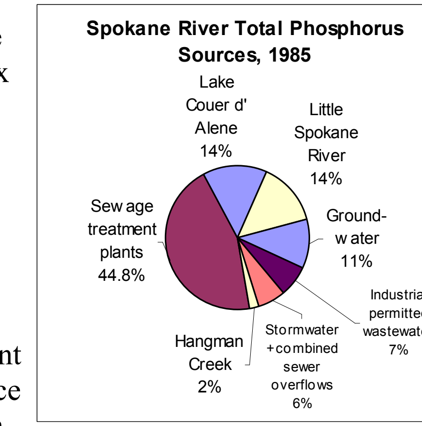
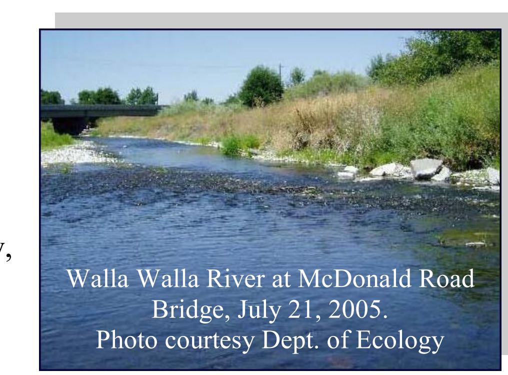
When the City of Spokane's sewage treatment plant upgraded its treatment in 1977, water quality improved. But low dissolved oxygen conditions in the lake persisted, so in 1999-2000 Ecology re-evaluated the river using a more complex model and additional data (which updated the 1985 loads in the pie chart to the right). The modeling showed that to 'starve' the algae, total phosphorus concentrations should be no more than 0.01 mg/L in the river, instead of the 0.025 mg/L goal previously set in 1987.



Ecology also found that the oxygen depletion caused by less than one-third of existing nonpoint sources alone was enough to violate state standards, leaving virtually no allowable loading for the permitted point sources. Sewage treatment plants (point sources) will need to upgrade to very expensive state-of-the-science treatment technology to reduce phosphorus in effluent to less than 0.05 mg/L in the near future and ultimately to 0.01 mg/L. Ecology also recommended other strategies, including: (1) control phosphorus coming into sewage treatment plants through water conservation and waste management (for example, banning phosphorus detergents); (2) use treated water for irrigation; (3) try alternative wastewater treatment; (4) improve combined sewer overflow and stormwater control; and (5) increase the amount of water in the river.

The model indicated that even if phosphorus reduction goals are met, the river may still fail to meet the dissolved oxygen standard during the hottest days of the year in two areas: (1) the water-losing reach of the river upstream of Sullivan Road; and (2) the lake, depending on the duration of summer stratification (when cool water sinks to the bottom of the lake) and natural sediment oxygen demand (oxygen is consumed as organic matter in the lakebed decays).

Walla Walla River


Walla Walla River at McDonald Road Bridge, July 21, 2005. Photo courtesy Dept. of Ecology

In the Walla Walla River, algae growing on the river bottom caused violations of the state standards. Out of six short-term deployments of continuous monitors during the summer of 2002, minimum dissolved oxygen concentrations fell below the standard of 6.5 mg/L on three days, while maximum pH values exceeded the standard of 8.5 on ten days. Ecology found it was the combination of excess nutrients, low stream flow, and exposure to sun which causes excessive algal growth in the river.

Based on nitrogen-to-phosphorus ratios, Ecology determined that nitrogen appeared to be the limiting nutrient from May through October in most of the basin but phosphorus should be controlled as well due to its importance in certain locations and during the winter. Eighty percent of the dissolved inorganic nitrogen in the Walla Walla River comes from its tributaries — the Touchet River and Yellowhawk, Garrison, and Mill Creeks. Clean-up goals for the tributaries were equivalent to natural background conditions, ranging from 0.025 to 0.047 mg/L soluble reactive phosphorus and 0.055 to 0.076 mg/L dissolved inorganic nitrogen. Goals for the Walla Walla River are 0.04 mg/L soluble reactive phosphorus and 0.4 mg/L dissolved inorganic nitrogen. To reduce nutrients in the tributaries, recommendations included: (1) Reduce the amount of nitrogen and phosphorus in the effluent from the Dayton sewage treatment plant within ten years after its permit is updated, (2) reduce stream temperatures, (3) increase flow in the river, (4) monitor storm sewer systems to evaluate their nutrient contribution, (5) involve the Gose and Blalock irrigation districts in limiting nutrients to Mill Creek, (6) monitor Walla Walla and College Place's sewage treatment plants to make sure they do not contribute nutrients via irrigation return drains or groundwater, and (7) encourage reductions from upstream in Oregon, including Oregon tributaries.

Ecology concluded that due to naturally high phosphorus concentrations (> 40 ug/L soluble reactive phosphorus) in the headwaters of the river, naturally elevated pH of over 7.5, and the width of the river (reducing the potential effectiveness of shading by planting trees), even if the recommendations in the plan are fully implemented, the river will not likely meet the dissolved oxygen and pH standards at all times and in all places.